A Comparison of ADAMS Predictions to Data from the WindLite 8kW Truck Test

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Background

- Several furling turbines under development for the NWTC
- Hope was to use models to set furling parameters
- Truck test was intended to validate model of WindLite 8kw turbine
- AeroDyn and Crunch modified for study.

AeroDyn Modifications

- Modified AeroDyn v11.21
- Added ability to select airfoil table based upon Reynolds number
- Added tail-vane aerodynamics

ADAMS Model

- Degrees of Freedom
  - Yaw
  - Tail furl
  - Blade flapping hinge
- Variable input parameters
  - Rotor offset
  - Tail pivot angle
  - Nacelle tilt (unused)

ADAMS Model (cont.)

- Aerodynamic Properties
  - X-Foil predictions for SG6050 and SG6051
  - Flat plate for tail, no unsteady aero
- Torque/Speed
  - Bench test currents outside range of truck-test data
  - Fit line to truck torque/speed data

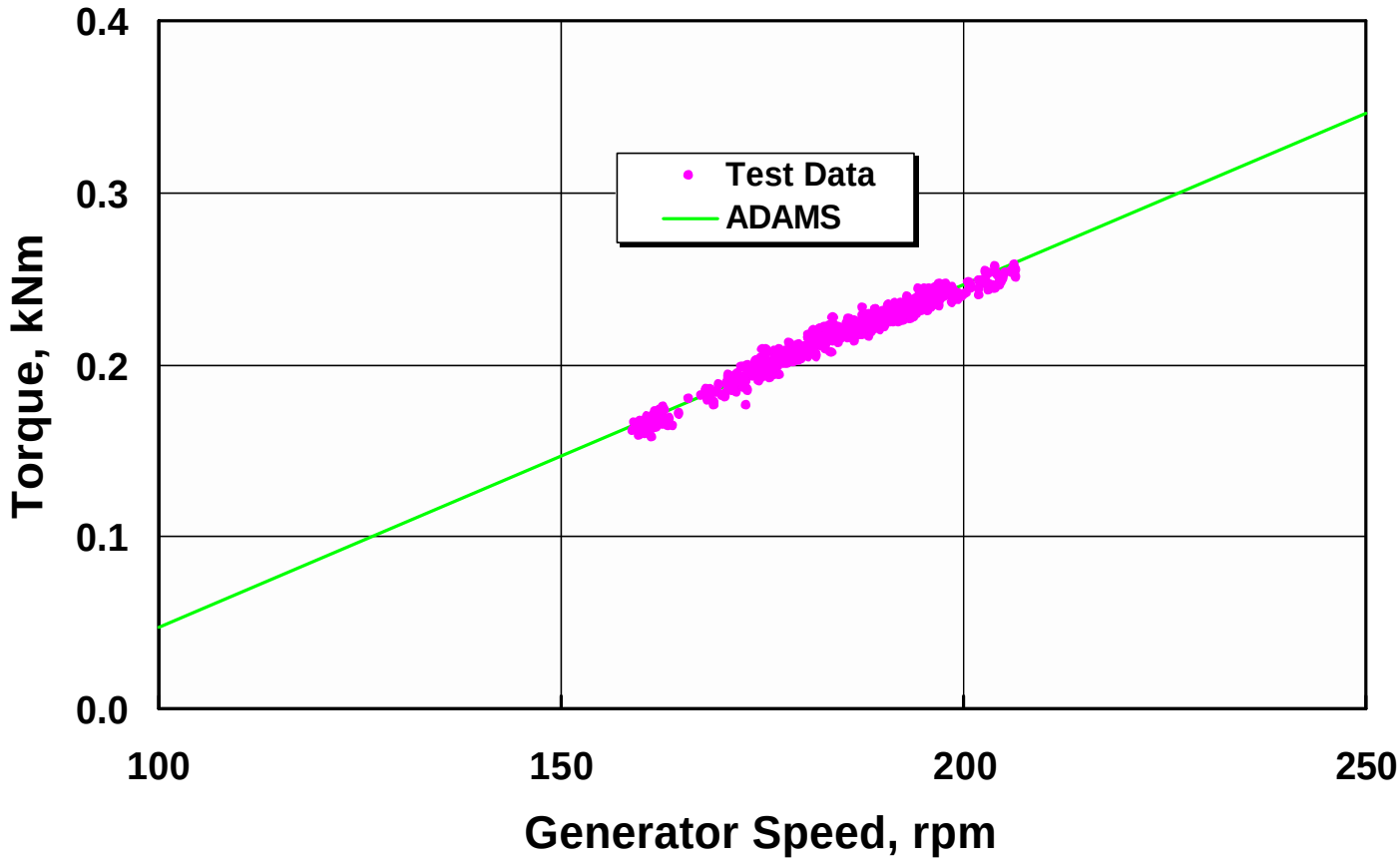
Test-Data Processing

- Tower strain-gage data
  - Applied 0.1 Hz low-pass filter
  - Removed crosstalk
  - Converted to engineering units
- Calculated Channels
  - Time
  - Fore-aft and side-to-side thrust
  - Generator Power = Potential*Current
  - Generator Torque = Power/Speed

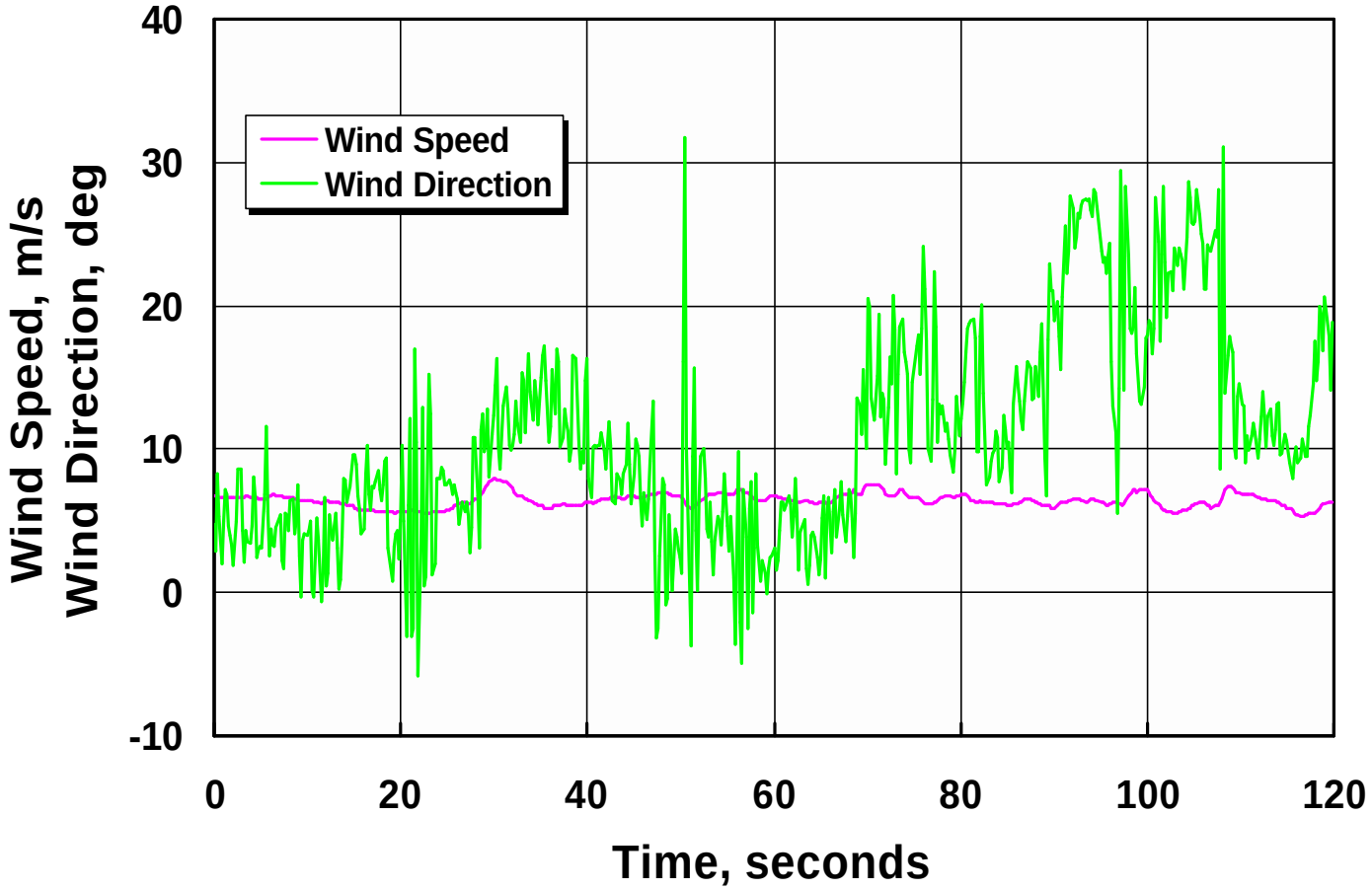
Problems

- Non-steady wind speed (± 1 m/s)
- Non-zero wind direction
- Non-steady truck speed? Inertia effects?
- Truck roll?
- No tail-fin weight data
- Turbine furled at beginning of tests

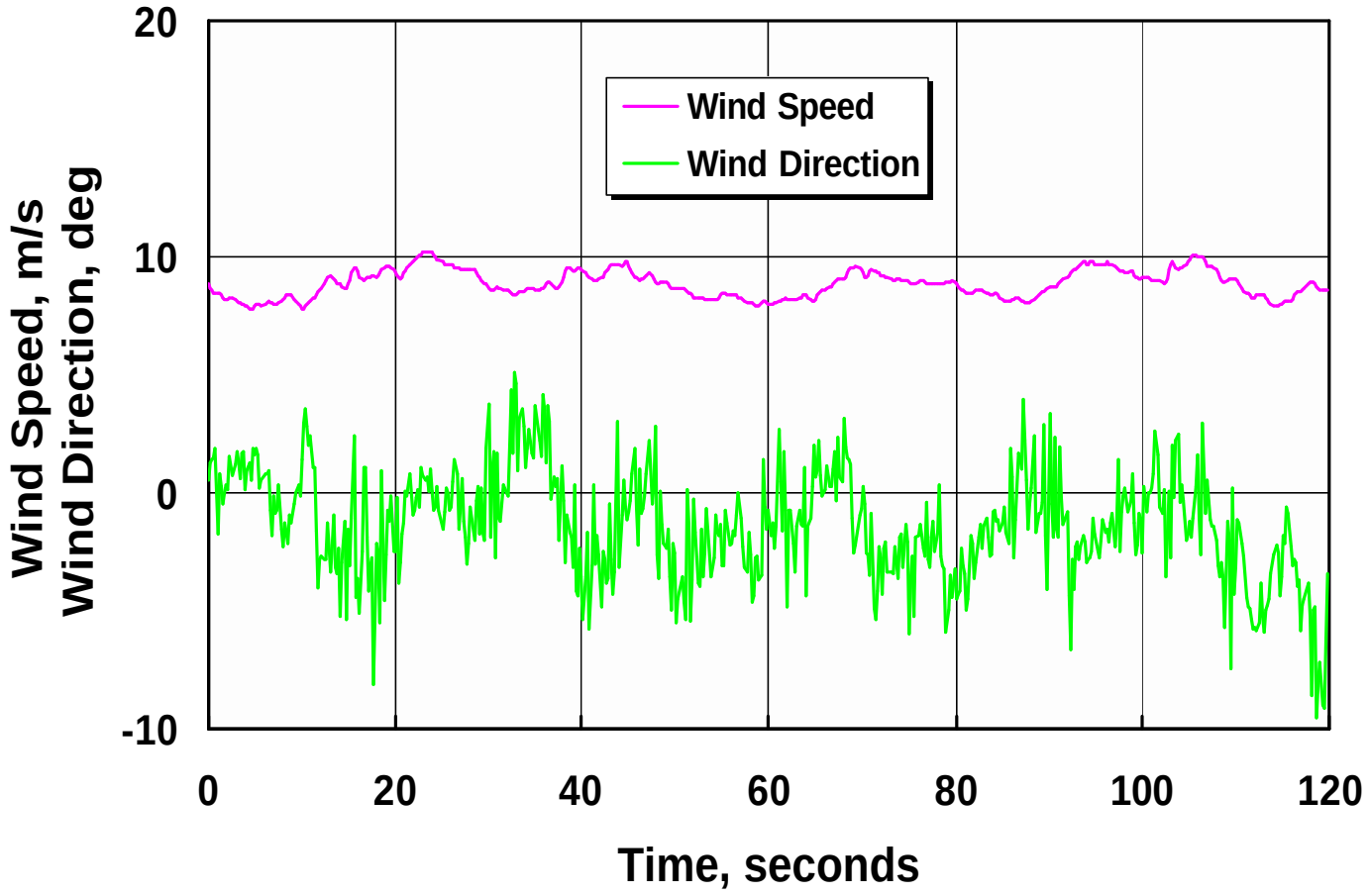
Torque vs. Speed



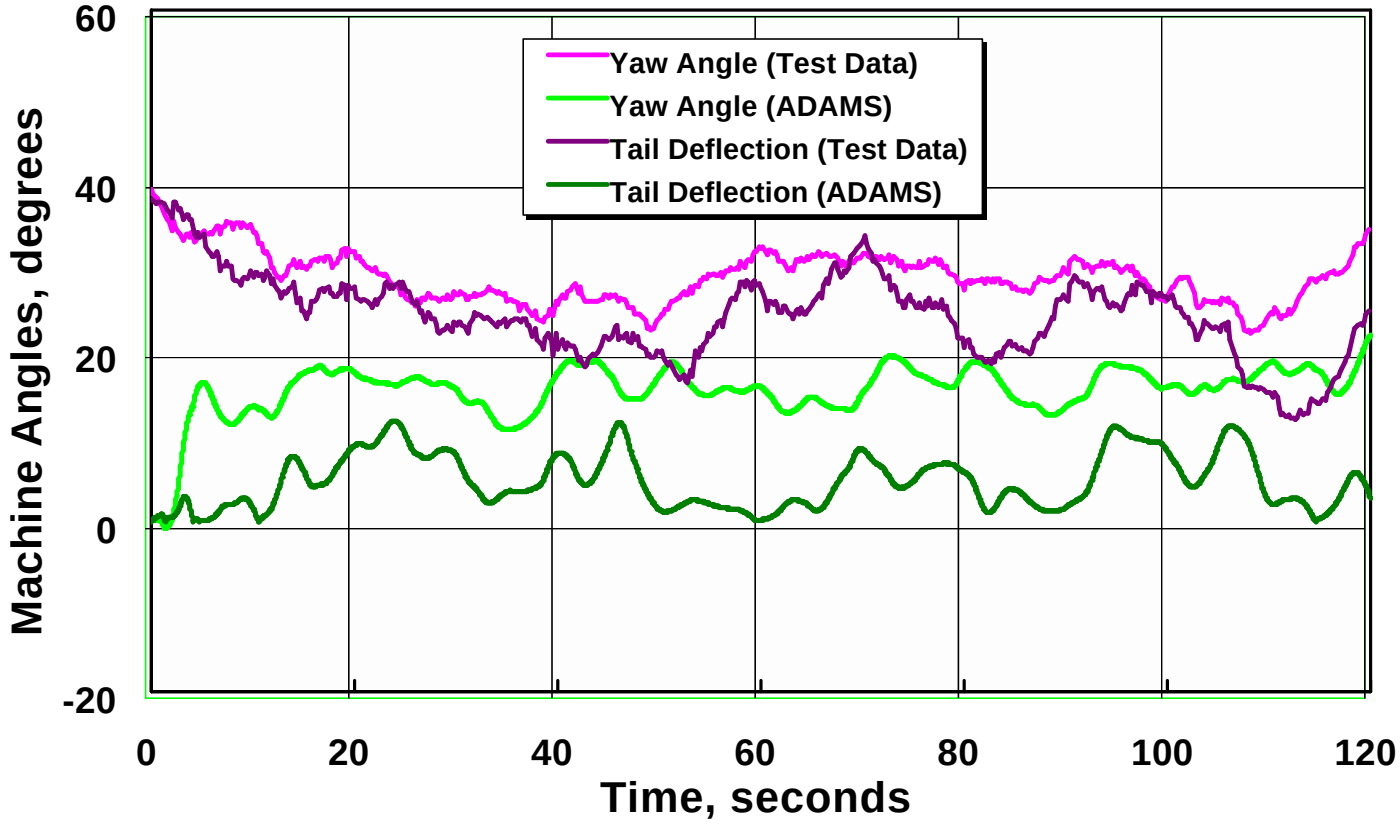
Poor Wind Conditions



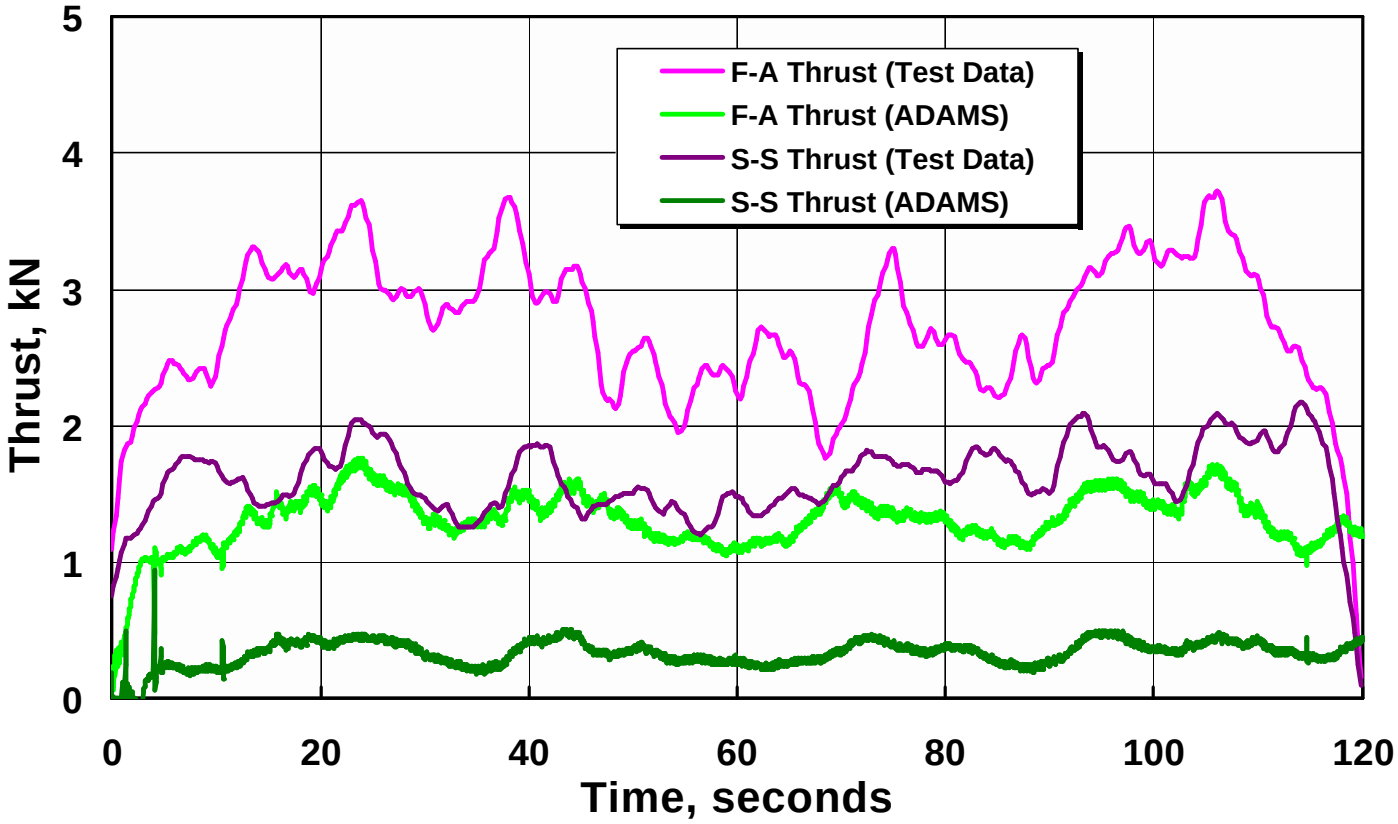
Fair Wind Conditions



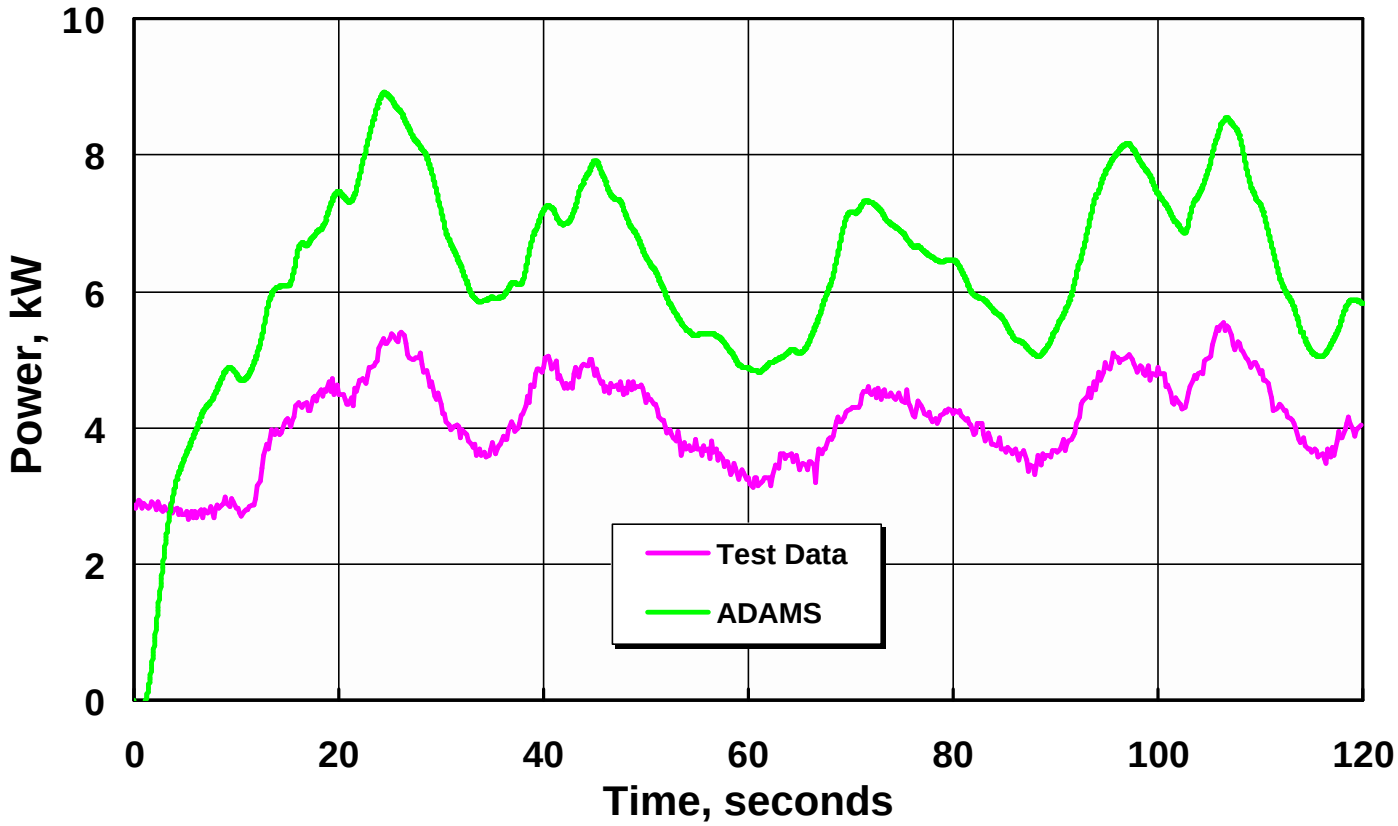
Yaw and Tail Deflection



Thrust


F-A Thrust (Test Data)
F-A Thrust (ADAMS)
S-S Thrust (Test Data)
S-S Thrust (ADAMS)
Thrust, kN
0
1
2
3
4
5
0
20
40
60
80
100
120
Time, seconds

Generator Power



Conclusions

- Model furls only half as much as the tested turbine
- Cause of errors is unknown
  - Modeling errors?
  - Errors in aerodynamic algorithms?
  - Tilted/non-inertial turbine?

Possible Problems with Truck Tests

- Distortion of flow field around truck
- Non-level road
- Turbine CM shift due to furling and yawing can tilt truck and tower
- Non-steady truck speed
- Vibration impact on sensors
- Turbine thrust limits wind speed

Recommendations

- Field test preferred over a truck test for validating an ADAMS model
- If truck test is desired
  - Add accelerometers and inclinometers to tower top
  - Filter strain-gage data